Impact of a vaccine passport on first-dose COVID-19 vaccine coverage by age and area-level social determinants in the Canadian provinces of Québec and Ontario: an interrupted time-series analysis

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Abstract

Background: In Canada, all provinces implemented vaccine passports in 2021 to increase vaccine uptake and reduce transmission in non-essential indoor spaces. We evaluate the impact of vaccine passport policies on first-dose COVID-19 vaccination coverage by age, area-level income and proportion of racialized residents.

Methods: We performed interrupted time-series analyses using vaccine registry data linked to census information in Québec and Ontario (population of 20.5 million people ≥12 years; unit of analysis: dissemination area). We fit negative binomial regressions to weekly first-dose vaccination, using a natural spline to capture pre-announcement trends, adjusting for baseline vaccination coverage (start: July 3rd; end: October 23rd Québec, November 13th Ontario). We obtained counterfactual vaccination rates and coverage, and estimated vaccine passports' impact on vaccination coverage (absolute) and new vaccinations (relative).

Results: In both provinces, pre-announcement first-dose vaccination coverage was 82% (≥12 years). The announcement resulted in estimated increases in vaccination coverage of 0.9 percentage points (p.p.;95%CI:0.4-1.2) in Québec and 0.7 p.p. (95%CI:0.5-0.8) in Ontario. In relative terms, these increases correspond to 23% (95%CI:10-36%) and 19% (95%CI:15-22%) more vaccinations. The impact was larger among people aged 12-39 (1-2 p.p.). There was little variability in the absolute impact by area-level income or proportion racialized in either province.

Interpretation: In the context of high baseline vaccine coverage across two provinces, the announcement of vaccine passports led to a small impact on first-dose coverage, with little impact on reducing economic and racial inequities in vaccine coverage. Findings suggest the need for other policies to further increase vaccination coverage among lower-income and more racialized neighbourhoods and communities.

Keywords: Vaccination; vaccine mandates; vaccine passports; COVID-19; social determinants of health.

Introduction

The threat posed by the coronavirus disease (COVID-19) pandemic led to unprecedented interventions, including both generalized and targeted restrictions. Once vaccines became widely available in 2021 in high-income countries, many governments implemented proof-of-vaccination policies to further mitigate the pandemic's impacts on population health and the economy.[1] Often termed "*vaccine passports*", these policies generally required demonstration of vaccination status or a valid exemption to access non-essential activities and spaces, including restaurants, bars, movie theatres, and concerts.

All Canadian provinces and the Yukon territory introduced vaccine passports in 2021 and discontinued the policy by April 2022. Québec and Ontario —the two most populous provinces and Canadian epicenters of the pandemic—[2–4] were among the first to announce vaccine passports. Provincial governments stated that these policies aimed to reduce SARS-CoV-2 transmission and prevent re-closure of non-essential venues by increasing vaccination coverage and limiting contacts of individuals who had not yet been vaccinated in non-essential venues.[5–7]

The ethical and practical implications of vaccine passports have been debated,[1,8–11] yet evidence on their effectiveness at incentivizing and increasing coverage of COVID-19 vaccination remains limited. Studies in Europe and Canada found that introducing vaccine passports led to increases in vaccination uptake, but this impact depended on age and prior vaccine coverage.[12–14] These studies have been limited by their use of provincial- or national-level data that restricted exploration of heterogeneity by age and have not examined the effects of vaccine passports according to social determinants of health (SDOH). Given that the COVID-19 pandemic has disproportionately affected communities experiencing social and economic marginalization,[4,15] it is essential to examine whether vaccination policies resulted in socioeconomic disparities in coverage.

Using vaccine registry data linked to area-level census information, we evaluated the impact of vaccine passports on first-dose vaccination coverage in Québec and Ontario using an interrupted time-series methodology. For each province, we estimated the impact of the vaccine passport by age, and two area-level social determinants: income and proportion racialized.

Methods

Study setting and population

In Québec and Ontario, vaccination of the general adult population (≥18 years) and youth 12-17 years began in May 2021 with BNT162b2 (Pfizer-BioNTech), mRNA-1273 (Moderna), or ChAdOx1 (Oxford-AstraZeneca).[16–19] COVID-19 proof-of-vaccination policies (herein "vaccine passports") were announced on August 5th (Québec) and September 1st (Ontario) and came into full force on September 15th (Québec) and September 22nd, 2021 (Ontario).[6,7,20] Non-essential activities and venues targeted by these policies were similar in both provinces, and restrictions applied to those aged 13 (Québec) or 12 (Ontario) years and over.

Data sources and measures

We obtained vaccination data from the *Registre de vaccination du Québec* and Ontario's *COVax* system,[21,22] which include individuals' dose administration date, age, and address or dissemination area (DA) of residency. Data were aggregated at the DA level — the smallest standard geographic area for which census information is available (average 400-700 residents).[23] We included all individuals aged ≥12 years (population eligible for vaccination at time of announcement). Age was categorized based on vaccination priority (12-17, 18-29, 30-39, 40-49, 50-59, and 60+ years). We computed the weekly vaccination rate by DA and age group (number of first doses administered per 100,000 people without a first dose). We evaluated first-dose coverage because it may better capture people's response to vaccination mandates, whereas second-dose coverage depended primarily on time since first dose and changes in the recommended dosage interval (initially 16 weeks, shortened during the summer of 2021).[24–27]

We obtained DA-level after-tax income, per person equivalent from the *Postal Code Conversion File Plus Version 7A/7D*,[28] and the proportion racialized (based on self-reported "visible minority") from the latest available Canadian Census (2016) at the time of analysis.[29] Income was ranked at the census metropolitan area level (to account for within-province variability in cost-of-living) from lowest to highest, while proportion racialized was ranked at the provincial level from highest to lowest. This ordering was chosen such that the first quintile would align with observed data on the highest incidence of COVID-19 cases.[4,15] The ranking balanced the population in each quintile.

Study design and statistical analysis

Analyses were stratified by province. We performed interrupted time-series (ITS) analysis to estimate the impact of the vaccine passport by modeling a counterfactual scenario based on the pre-intervention temporal trend.[30,31] We allowed for temporary changes in level and slope of the vaccination rate as a result of the policy announcement. The change lasted for six weeks in both provinces: August 14th to September 18th (Québec) or September 4th to October 9th (Ontario). Québec's date was lagged by one time unit because inspection of the raw data suggested that changes in the weekly rate were only detectable one week post-announcement, likely because of the announcement timing and decreased vaccination during weekends. The study period was from July 3rd (to align with the end of school year) to five weeks after the end of the vaccine passports' impact period (i.e., October 23rd for Québec and November 13th for Ontario).

Our modeling approach consisted of two steps. First, we used negative binomial regressions with a natural spline to capture pre-announcement trends of DA-level vaccination rates, adjusting for baseline vaccination coverage (i.e., July 3rd 2021; categorical with six groups).[32,33] Second, we used model coefficients to obtain counterfactual vaccination rates and coverage. We computed the absolute impact of the vaccine passports (observed minus counterfactual coverage) at the end of the study periods (Québec: October 23rd, 2021; Ontario: November 13th, 2021). We calculated the relative increase in number of first vaccine doses administered between the announcement and the end of the study period.

We investigated heterogeneity in the impact of vaccine passports by age[12] and by area-level SDOH associated with higher COVID-19 infection burden.[4,15] We fit three models in which the vaccine passport impact could vary by age, area-level income, or area-level proportion racialized. To further examine trends by SDOH, we fit two models with interaction terms between age and area-level income or proportion racialized. We evaluated impact heterogeneity by assessing trends in absolute and relative impacts of the vaccine passport by age and SDOH. To examine how passports affected inequities in vaccination coverage, we focused on absolute impacts.

Since heterogeneities in the impact of vaccine passports could be influenced by differences in baseline vaccination coverage, we re-fit the first three models with an interaction term between baseline coverage and the impact of the vaccine passports. We then re-estimated the absolute impact of vaccine passports while holding baseline coverage constant (i.e., setting the baseline variable for all DAs to the same value).

Finally, we replicated the main analyses restricting to DAs in the Montréal and Toronto census metropolitan areas (with DAs re-ranked according to SDOH). These cities are the largest census metropolitan areas of each province, have sociodemographic profiles that differ from the rest of their province, and were important epicenters of SARS-CoV-2 transmission.

Confidence intervals (CIs) were obtained using 1,000 bootstrap replicates, using census tracts as the resampling unit to account for geographical and temporal correlations. The 95% CIs were computed by taking the 2.5th and 97.5th quantiles.

Sensitivity analyses

We explored how alternative modeling choices affected model fit and results by re-parametrizing how the vaccine passport impact was modeled in the age model.[34] Briefly, we assessed if the chosen start of the study period influenced conclusions by changing the start of the time-series (±1 week), assessed the robustness of our results to different impact period lengths (5 or 7 weeks), and examined different model specifications for the time trend (non-spline methods). Fits were compared based on Akaike Information Criterion, Bayes Information Criterion, and visual assessment.

All analyses were carried out in R V.4.1.0, using packages *fixest* and *splines*.[35–37] Full details on our modeling approach, model equations, and sensitivity analyses can be found in *Supplementary Materials*.

Ethics approval

Ethics approvals were obtained from the *Institutional Review Board* of Faculty of Medicine and Health Sciences of McGill University in Québec (A06-M52-20B) and the *Health Sciences Research Ethics Board* of University of Toronto in Ontario (no. 39253).

Results

Observed COVID-19 first-dose vaccination coverage over time

In both provinces, first-dose COVID-19 vaccination coverage was 82% in the eligible population (≥12 years) when the vaccine passport was announced. Coverage was highest among people aged 60+ years

(94% Québec; 87% Ontario), while coverage for those aged 12-17 years was 68% and 76%, respectively. By the end of the study period, overall vaccination coverage had increased by about 5 percentage points (p.p.) in each province (Table 1).

Pre-announcement vaccination coverage in the lowest-income DAs was 9 and 7 p.p. lower than highest-income DAs in Québec and Ontario, respectively (similar inequalities in Montréal and Toronto). There were also disparities by proportion racialized: coverage in DAs with the highest-proportion racialized was 4 p.p. and 8 p.p. lower than the lowest-proportion ones in Québec and Montréal, respectively. In Ontario, these inequalities were reversed — vaccine coverage was 3 p.p. higher in the highest-proportion racialized as compared to the lowest ones, and there was little difference in Toronto (<1p.p.; Supplementary Table S2).

Table 1. Population sizes and first-dose COVID-19 vaccine coverage for select time points in Québec and Ontario, 2021.

			COVID-19 first-dose vaccine coverage (%)		
			Start of timeseries	Last pre-announcement time point	End of time series
Province and age group	**Number of DAs**	**Population (≥12 years)**	**July 3rd 2021**	**August 7th 2021**	**October 23rd 2021**
Québec	**13,407**	**7,448,493**	**79.5%**	**82.3%**	**87.6%**
12–17 years		565,510	62.9%	67.6%	77.8%
18–29 years		1,188,905	67.4%	72.1%	81.8%
30–39 years		1,139,855	68.4%	72.3%	80.4%
40–49 years		1,117,506	77.5%	80.6%	86.1%
50–59 years		1,093,538	85.0%	87.3%	91.0%
60+ years		2,343,179	93.5%	94.3%	95.5%
			July 3rd 2021	**August 28th 2021**	**November 13th 2021**
Ontario	**17,372**	**13,039,268**	**76.1%**	**81.6%**	**86.4%**
12–17 years		980,166	62.5%	76.2%	84.9%
18–29 years		2,311,994	71.5%	79.9%	88.0%
30–39 years		2,099,736	67.7%	74.2%	81.0%
40–49 years		1,879,004	74.9%	80.0%	85.1%
50–59 years		2,017,403	81.9%	85.9%	89.3%
60+ years		3,750,965	84.6%	86.6%	88.0%

DA, dissemination area.

Observed pre- and post-passport announcement vaccination rates

Prior to the announcement of vaccine passports, weekly first-dose vaccination rates were stable in Québec and declining in all age groups in Ontario (Figure 1). Increased vaccination rates were observed in both provinces in the week that followed the announcement of the passports, especially among younger age groups (12-17 and 18-29 years old). Comparable increases occurred across income and proportion racialized quintiles. These increases were sustained over a period of six weeks. Similar patterns were observed for Montréal and Toronto (Supplementary Figure S1).

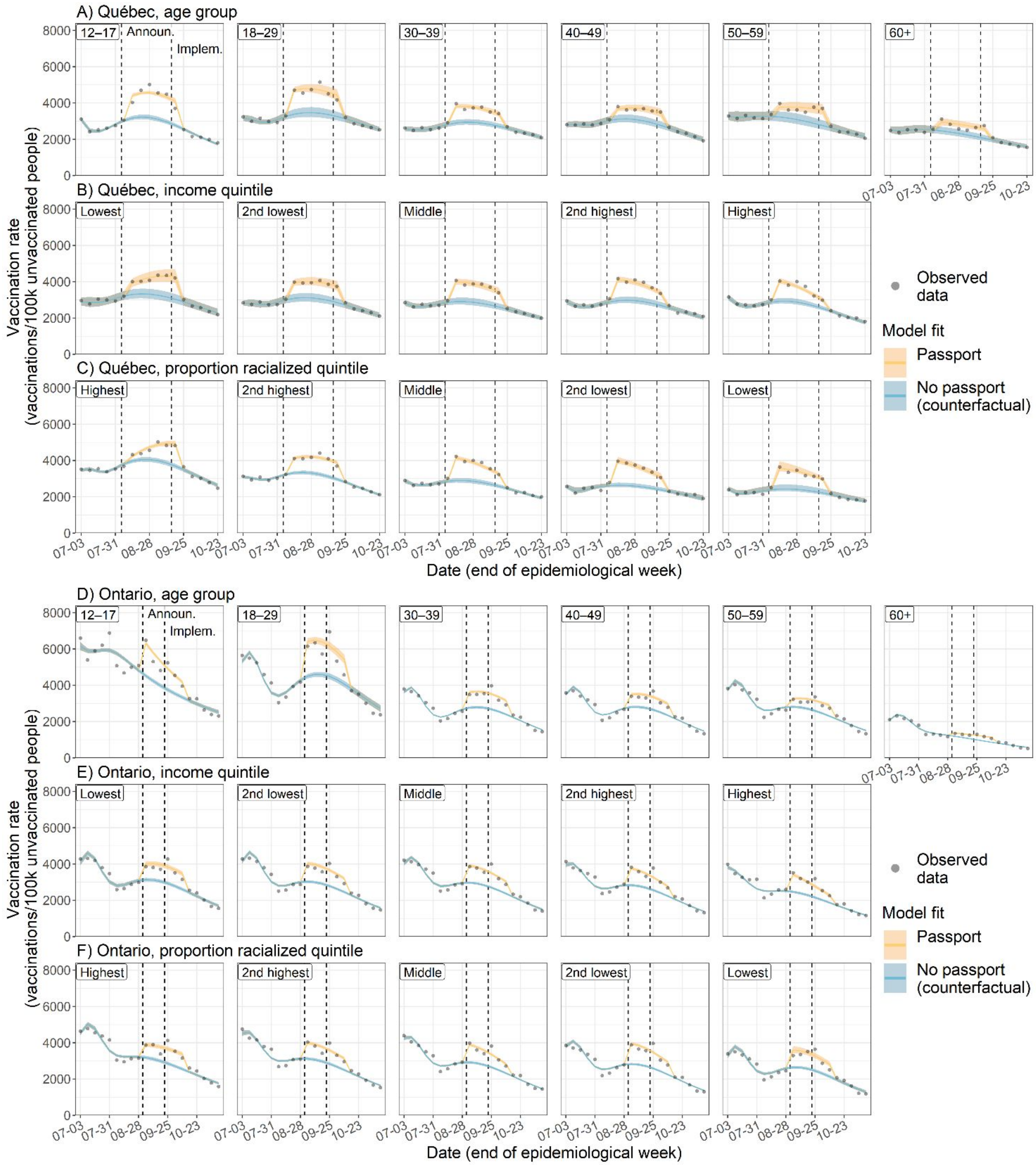

Figure 1. Weekly vaccination rates in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccination rates over time are shown. Predicted vaccination rates were obtained from three different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by age group (A, D), dissemination area (DA)-level income quintile (B, E), or DA-level proportion racialized quintile (C, F). 95% confidence intervals were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.

Interrupted time-series: vaccine passports' impact on coverage by age

We estimated that, in the absence of the vaccine passports, first-dose vaccination coverage would have been 0.9 p.p. lower (95%CI: 0.4-1.2) in Québec by October 23rd and 0.7 p.p. lower (95%CI: 0.5-0.8) in Ontario by November 13th. In relative terms, vaccine passports led to increases in vaccinations of 23% in Québec (95%CI: 10-36%) and 19% in Ontario (95%CI: 15-22%; Figure 2).

The largest impact of the vaccine passport was observed in the 12-17 age group in Québec, where vaccine coverage was 2.3 p.p. higher (95%CI: 2.0-2.7) than it would have been without a vaccine passport. In Ontario, the corresponding impact was a 1.3 p.p. (95%CI: 0.9-1.7) increase. The smallest effects were estimated in the 60+ age group, where the impact was around 0.1 p.p. in both provinces (Figure 2A&D). Similar age patterns were observed in the relative scale (Supplementary Table S2). In Montréal and Toronto, the effect sizes for each age group (except for the 12-17 age group in Toronto) were equivalent to provincial estimates (Supplementary Figure S2). The observed age trends for the absolute impact remained when holding baseline vaccine coverage constant across DAs (Supplementary Figure S3).

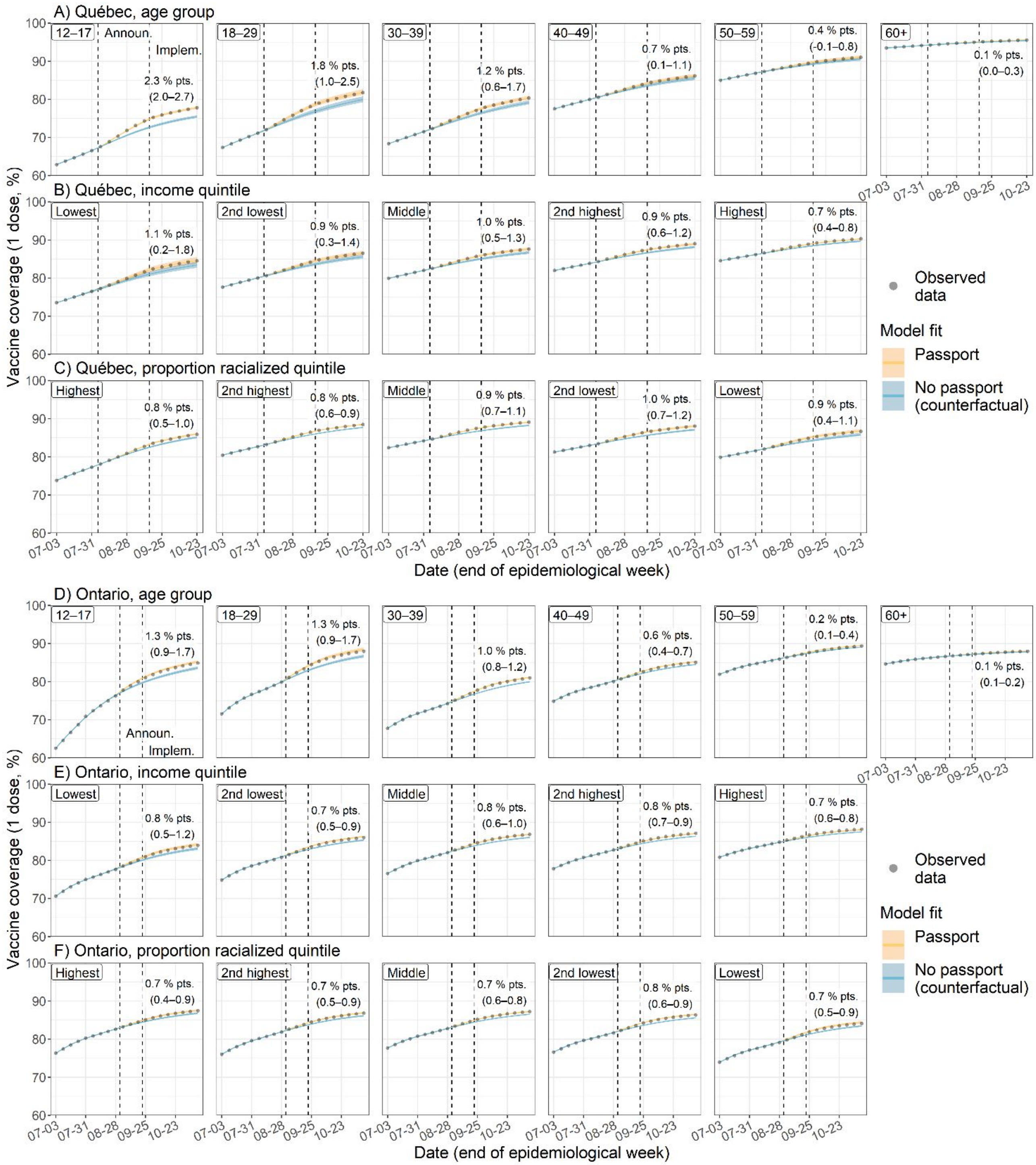

Figure 2. First-dose COVID-19 vaccine coverage in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccine coverage over time are shown. Predicted vaccine coverage was obtained from three different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by age group (A, D), DA-level income quintile (B, E), or DA-level proportion racialized quintile (C, F). Estimates and 95% confidence intervals (CIs) of the impact of the vaccine passport (observed coverage minus modeled counterfactual) are shown at the right of each panel. 95% CIs were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.

Modification of vaccine passports' impact on vaccine coverage by age and social determinants of health

When examining the impact by income quintile, we found little evidence of heterogeneity in Québec. In this province, the vaccine passport increased vaccine coverage in the lowest-income DAs by 1.1 p.p. (95%CI: 0.2-1.8) compared to 0.7 p.p. (95%CI: 0.4-0.8) in the highest-income DAs, corresponding to relative increases of 21% (95%CI: 4-40%) and 27% (95%CI: 15-36%), respectively (Figure 2B, Supplementary Table S2). When stratifying by age, the impact of vaccine passports was generally larger in lower-income DAs in most age groups (no clear trend in the 18-29 group). However, uncertainty was large and CIs overlapped across quintiles (Figure 3A).

The impact was comparable across income quintiles in Ontario at around 0.7 to 0.8 p.p. (Figure 2D), although the relative increase in vaccinations ranged from 19% (95%CI: 10-29%) in the lowest-income DAs to 32% (95%CI: 25-40%) in the highest-income ones (Supplementary Table S2). The lack of heterogeneity in the absolute impact remained with age stratification — the estimated vaccine passport impact was larger in younger age groups but similar across income quintiles within each age group (Figure 3C).

For the proportion racialized, the impact was homogeneous at the DA-level. In Québec, the increase in vaccine coverage was around 0.7 to 1.0 p.p. across quintiles of proportion racialized, with no clear trend (Figure 2C). The relative impact ranged from increases in vaccination of 12% (95%CI: 7.5-18) in DAs with the highest proportion racialized to 29% (95%CI: 10-41%) in the lowest-proportion ones (Supplementary Table S2). Within age groups, the impact was larger in DAs with lower proportion racialized, except for the 12-17 age group where the impact was larger in higher-proportion DAs. Although CIs overlapped across some quintiles, uncertainty was smaller than in the income analyses (Figure 3B).

In Ontario, the DA-level impact was also similar regardless of the proportion of racialized residents. The absolute effect of vaccine passports was 0.7-0.8 p.p. in all quintiles and relative impacts were also homogeneous, ranging from increases of 19% to 24% (Figure 2F, Supplementary Table S2). As in Québec, there was more heterogeneity when stratifying by age, and the impact was bigger in DAs with lower proportion racialized. The effect was attenuated in older age groups, but the gradient remained in all age groups (Figure 3D).

The patterns by income and proportion racialized in Montréal and Toronto were equivalent to those of their respective provinces. One exception was the pattern in the vaccine passport impact by proportion racialized in Toronto, as there was a slight gradient only among people aged 12-29 years (Supplementary Figures S2&S4). When holding baseline vaccination coverage constant, the trends along SDOH remained for all cases except for income in Ontario, where there was a slight gradient in the impact of the vaccine passport (Supplementary Figure S5).

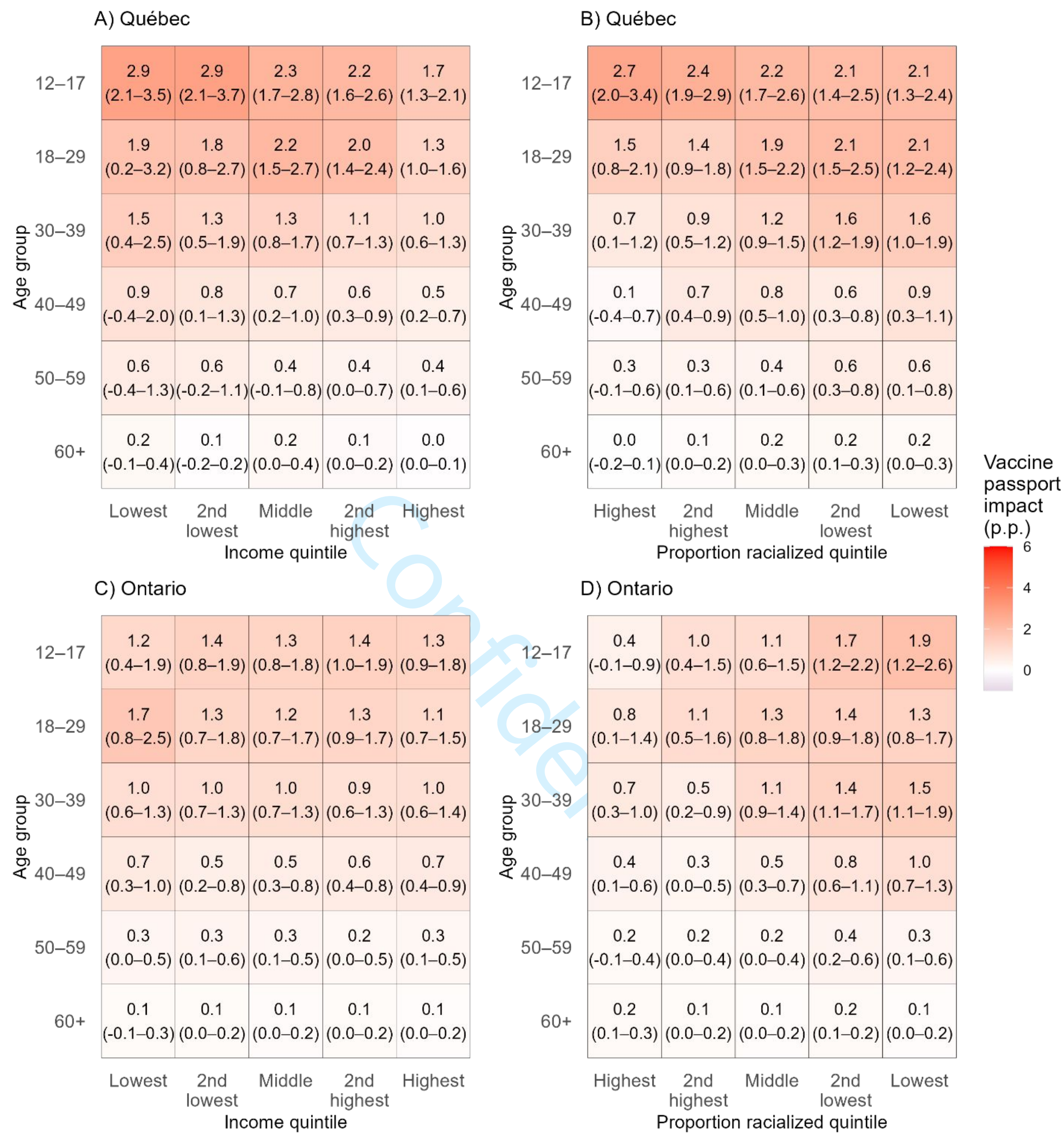

Figure 3. Impact of vaccine passport on first-dose coverage of COVID-19 vaccine (in percentage points) across age and by dissemination area (DA) level of income and proportion of racialized residents in Québec (A, B) and Ontario (C, D) by the end of the study period. The vaccine passport's impact (defined as the observed vaccination coverage minus the modeled counterfactual coverage in the absence of a vaccine passport) was estimated from two different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by the interaction of age and either DA-level income quintile (A, C), or DA-level proportion racialized quintile (B, D). 95% confidence intervals —in parenthesis—were estimated via bootstrap with 1,000 replicates. p.p., percentage points.

Sensitivity analyses

In sensitivity analyses (age model), changing the time-series start by ±1 week did not substantially change the estimated impacts in Québec and slightly lowered them in Ontario (Supplementary Figure S6). In contrast, in models that assumed a different duration for the vaccine passports' impact (5 or 7 weeks), the effect was slightly lower in both provinces, but model fit was also poorer using these specifications (Supplementary Figures S7-S8). Lastly, when using the best non-spline alternative model specifications, the estimated impact of the vaccine passport was slightly higher in Québec and lower in Ontario, as compared to our spline-based approach. All impact estimates were higher when modelled using a simple log-linear model, but these methods had poorer fit (Supplementary Figure S9-S10).

Discussion

Vaccine passports increased COVID-19 first-dose vaccine coverage by approximately 1 p.p. in both Québec and Ontario, where first-dose vaccine coverage was above 80% (≥12-year-old population) at the time passports were announced. This translates to relative increases of 23% (Québec) and 19% (Ontario) in vaccinations among people without a first dose. The impact was largest among younger age groups (<40 years), even after controlling for baseline vaccine coverage. Differences in the impact of vaccine passports by area-level income or proportion of racialized residents were relatively small and the estimates' uncertainty overlapped, suggesting that vaccine passports had limited impact on reducing socioeconomic disparities in vaccination coverage.

In both provinces, there were inequalities in the pre-announcement vaccination coverage by DA-level income. However, there was only a small gradient in the impact of the vaccine passport in Québec (i.e., higher impact in lower-income DAs) and confidence intervals overlapped. In Ontario, there was little heterogeneity in the impact of vaccine passports by DA-level income. Taken together, these results suggest that there was little heterogeneity by area-level income in the impact of vaccine passports.

The fact that there were inequalities in baseline vaccine coverage by DA-level proportion of racialized residents in Québec, but not Ontario, could be attributed to different vaccination policies. Québec's vaccine prioritization focused mostly on age and essential workers, whereas Ontario eventually implemented a "hotspot strategy," which directed more vaccine-related resources to geographical areas with higher cumulative COVID-19 incidence — which on average had a higher proportion of racialized residents.[38,39] Although estimates were uncertain, larger absolute effects were observed in neighbourhoods with lower proportions of racialized residents in age-stratified analyses in both provinces. This suggests that vaccine passports may have had slightly larger impacts in predominantly white neighbourhoods despite their higher baseline coverage — a heterogeneity that was masked by differences in age structure and that could manifest in increased disparities in lower-coverage settings.

Our effect size estimates are lower than those previously reported from Europe and Canada.[12–14] Two studies that evaluated vaccine passports in Italy, France, and Germany found absolute increases in vaccine coverage of 5-13 p.p.[13,14] In these countries, however, passports were announced when the fraction of people without a first dose was much larger (30-35%, versus <20% in our study). In Canada, a study reported slightly higher effects for vaccine passports in Québec (3.1 p.p.) and Ontario (1.9 p.p.).[14] In contrast to our approach, the authors assumed that vaccine passports would have a permanent effect beyond six weeks and did not account for the continuous reduction in size of the population without first dose, potentially overestimating the impact of vaccine passports.

Our results should also be interpreted by considering vaccine acceptance/hesitancy as a continuum between total acceptance and total refusal.[40,41] First, vaccine passport policies may have had the biggest impact on those open to vaccination but for whom it was not a priority. This could partly explain the observed age effect: younger people may have decided to get vaccinated or moved their vaccinations forward in time to maintain access to non-essential settings and activities targeted by vaccine passports. Second, there was a large “early adopter” effect by the time vaccine passports were announced. Indeed, the majority of residents in Canada expressed positive attitudes toward COVID-19 vaccinations[42] and there were various community-based efforts to improve engagement, awareness, and access (e.g., community ambassador programs, mobile vaccination clinics). Those not yet vaccinated by the time of the announcements may have largely comprised individuals experiencing long-standing, systemic, and persistent barriers to vaccination and/or vaccine mistrust. Our findings suggest that different strategies are needed to address these issues and increase vaccine acceptance and uptake in these communities.[43]

Various limitations should be considered when interpreting these results. First, concurrent events (e.g., return to school, university-/college-based mandates in Ontario, vaccine lottery in Québec) may have biased estimates of effectiveness upwards. However, school-related events would only partly affect age groups <30, and there is mixed evidence on the impact of vaccine lotteries for COVID-19 vaccination.[44,45] Second, we used area-level measures of income and racialization, meaning that inferences on the role of individual-level income or racialization could be subject to ecological fallacy. Lastly, this study does not address other ways in which vaccine passports could affect SARS-CoV-2 transmission (e.g., reduced mixing between people of different vaccination status). Strengths of our study include the use of detailed DA-level information on vaccinations in Canada’s largest provinces. We also conducted a range of sensitivity analyses that provided credence to our estimates. Lastly, we investigated heterogeneity of impact by age and area-level social determinants of health — known drivers of inequalities in COVID-19 burden.

Conclusion

In Québec and Ontario, vaccine passports increased COVID-19 vaccination coverage, but absolute gains were small given the provinces already had relatively high vaccination coverage. The impact of vaccine passports was largest among younger age groups in both provinces. However, the effect of vaccine passports varied little by neighbourhood-level SDOH. Ultimately, other policies that account for how social determinants shape barriers to vaccination may be necessary to further increase vaccination coverage and meaningfully reduce inequities in COVID-19-related morbidity and mortality.

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Declarations

Author contributions

MMG, SM, and JLFA designed the study. JLFA, HM, MAH, MMG, SM, and RB contributed to the conception of the analytical strategy. HM, MAH, and JLFA took care of data management. JLFA carried out all statistical analyses. YX, SH, DB, MB, MPH, KM, AK, RB, CW, ÉR, SB, and ÈD all provided substantial input to interpret the results. JLFA drafted the manuscript. All authors contributed to data interpretation and revision of the final manuscript.

Data availability

The analysis code is available at https://github.com/pop-health-mod/vaccine-passport-release.

The authors had access to data from the vaccination registries used in this study under agreements with the *Institut national de santé publique du Québec* and Ontario's *Ministry of Health*. These data are not available for public release.

The census data used in this study can be downloaded from Statistics Canada at https://www150.statcan.gc.ca/n1/en/catalogue/98-316-X2016001.

Supplementary materials

Supplementary methods and results are available online.

Conflict of interest

DB reports past contractual agreements with *Institut national d'excellence en santé et en services sociaux* (INESSS). MB reports grants from: Canadian Institutes of Health Research (CIHR), Medical Research Council, UK (MRC), the Bill and Melinda Gates Foundation, the Centers for Disease Control and Prevention (CDC), FRSQ/FCAR health research, the World Health Organization (WHO), the Public Health Agency of Canada (PHAC), the Québec Ministry of Health and Social Services, and the *Institut national de santé publique du Québec* (INSPQ). MMG reports a research grant from Gilead Sciences Inc., contractual agreements with the WHO and the Joint United Nations Programme on HIV/AIDS, and past contractual agreements with INESSS and INSPQ.

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Supplementary methods

Data sources and measures

Variables	Source	Definition
Population	Registered-persons databases	Number of people of a given age group in a dissemination area (DA), excluding long-term care home residents. These numbers were adjusted for over-vaccination through the following heuristic: if there were more doses than people in a given age group and DA by the end of the timeseries (Québec: October 23rd 2021; Ontario: November 13th 2021), we set the population size to the number of doses observed on that date.
After-tax income, per person equivalent (100% of census sample)	Postal Code Conversion File Plus Version 7A/7D	After-tax income is calculated for each household from the income for all household members. Calendar year 2015 is the reference period for all income variables in the 2016 Census. Single-person equivalent is used to account for households of different sizes. To account for differences in the cost of living, the ranking is calculated exclusively from DAs within the same census metropolitan area.
Proportion of visible minority (proportion racialized in the main text)	2016 Canadian Census *(25% of census sample)*	Visible minority refers to a person's self-identification as a visible minority as defined by the *Employment Equity Act*: "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour." According to the 2021 Census Dictionary, "the visible minority population consists mainly of the following groups: South Asian, Chinese, Black, Filipino, Arab, Latin American, Southeast Asian, West Asian, Korean and Japanese."

Identification strategy: interrupted time-series

We use an interrupted time-series approach to identify the impact of vaccine passports on vaccine coverage. This was preferred to a difference-in-difference analysis because of provincial differences in trends in vaccination rates prior to the announcement of vaccine passports (i.e., stable in Québec and decreasing in Ontario, violating the parallel trends assumption). For each province, we modeled the dissemination area (DA)-level weekly vaccination rate using negative binomial regression models to account for overdispersion (Supplementary Figures S11-S13), with an offset term for the population size without a first dose. The relationship between log-vaccination rate and calendar time was modeled using a natural spline (i.e., restricted cubic spline), with three knots placed at the 10th, 50th and 90th quantiles of the pre-announcement period.[1,2] Because pre-announcement vaccine coverage could influence subsequent weekly vaccination rates, we adjusted for DA-level vaccine coverage (age-stratified, except for models 2a and 2b which used vaccine data for the whole DA population) at the start of the timeseries (i.e., July 3rd 2021). Vaccine coverage at the start of the timeseries (July 3rd) was categorized into six groups: <50%, 50%–<60%, 60%–<70%,70%–<80%, 80–<90%, and ≥90%.

For the interrupted time-series, the impact of the vaccine passport was modeled to have an immediate change in the level and slope of the vaccination rate—as measured by regression coefficients β and δ in the regression formulas (see *Equations for the interrupted time-series analyses*). Based on inspection of the raw data, vaccine passports had transitory effects on vaccination rates. The length of this impact period was determined empirically via model comparison (Akaike Information Criterion, Bayes Information Criterion, and visual assessment). In both provinces, the best fit was provided by an impact period of 6 weeks, going from August 14th to September 18th (Québec) or September 4th to October 9th (Ontario).

Equations for the interrupted time-series analyses

Main model: weekly first-dose vaccination rates ($\boldsymbol{\lambda_{i,a,t}}$) in DA $\boldsymbol{i}$, for age group $\boldsymbol{a}$, at time $\boldsymbol{t}$ are modeled on the logarithmic scale

The main age-stratified model (model 1) takes the following form

$$\log(\lambda_{i,a,t}) = \alpha + f(T_t) + \beta P_t + \delta(T_t - I)P_t + \sum_{a'}[\gamma_{a'} + f_{a'}(T_t) + \beta_{a'}P_t + \delta_{a'}(T_t - I)P_t]A_{a,a'} + \sum_{c}(\psi_c * C_{i,a,c}) + offset(p_{i,a,t}),$$

where α is the model intercept; $f(T_t)$ is the natural cubic spline function of calendar time in weeks (T_t); β is the level change (for the reference group) in log vaccination rate during the impact period of the vaccine passport (i.e., the six weeks over which the policy is presumed to have an effect); P_t is the indicator variable for the impact period (its value is 1 during the six weeks of the impact period and 0 otherwise); δ is the coefficient for the slope change (for the reference group) in log vaccination rate during the impact period of vaccine passports and I indicates the week during which vaccine passports are announced; $\gamma_{a'}$ is the coefficient corresponding to age group a'; similarly, $\beta_{a'}$ is the coefficient for the age-specific level changes in vaccination rates and $\delta_{a'}$ the coefficient for the age-specific slope changes; $f_{a'}(T_t)$ is the spline function for age group a'; the indicator variable $A_{a,a'}$ is equal to 1 if $a' = a$ and 0 otherwise; ψ_c is the level-change due to differences in baseline vaccine coverage for baseline coverage group c; the indicator variable $C_{i,a,c}$ is equal to 1 if the baseline coverage in DA i and age group a is part of group c and 0 otherwise; finally, $p_{i,a,t}$ is the population size without a first dose in DA i, for age group a and at time t. For the indicator variables $A_{a,a'}$ and $C_{i,a,c}$, the reference group is 1 and the indices a' and c take values $\{2,3,4,5,6\}$.

Models with dissemination area-level income or proportion racialized

The equation above can be adapted to examine if vaccine passports had a differential impact by income quintile (model 2a). In this case, the s subscript indicates that the coefficient is for income quintile s, where $s = \{2,3,4,5\}$ (quintile 1 being the reference group), and $S_{i,s}$ is equal to 1 if DA i is in income quintile s and 0 otherwise. The equation is the following:

$$\log(\lambda_{i,t}) = \alpha + f(T_t) + \beta P_t + \delta(T_t - I)P_t + \sum_{s}[\gamma_s + f_s(T_t) + \beta_s P_t + \delta_s(T_t - I)P_t]S_{i,s} + \sum_{c}(\psi_c * C_{i,c}) + offset(p_{i,t})$$

Similarly, for the DA-level proportion of racialized residents, the model can be adapted as shown in the equation below (model 2b). The differences being that the v subscript indicates the proportion racialized quintiles and $V_{i,v}$ is an indicator variable for proportion racialized quintiles.

$$\log(\lambda_{i,t}) = \alpha + f(T_t) + \beta P_t + \delta(T_t - I)P_t + \sum_v [\gamma_v + f(T_t) + \beta_v P_t + \delta_v (T_t - I)P_t] V_{i,v} + \sum_c (\psi_c * C_{i,c}) + offset(p_{i,t})$$

Models with interaction terms between age and dissemination area-level income or proportion of racialized residents

The interrupted time-series models above can be modified to examine if vaccine passports have differential impact by age and our two social determinants of health (i.e., interaction). The notation above applies here and the equation for the model with interactions between age and income quintiles (model 3a) is the following:

$$\begin{aligned}\log(\lambda_{i,a,t}) = {} & \alpha + f(T_t) + \beta P_t + \delta(T_t - I) * P_t + \sum_c (\psi_c * C_{i,a,c}) + \\ & \sum_{a'} [\gamma_{a'} + f_{a'}(T_t) + \beta_{a'} P_t + \delta_{a'}(T_t - I)P_t] A_{a,a'} + \\ & \sum_s [\gamma_s + f_s(T_t) + \beta_s P_t + \delta_s(T_t - I)P_t] S_{i,s} + \\ & \sum_{a',s} [\gamma_{a',s} + f_{a',s}(T_t) + \beta_{a',s} P_t + \delta_{a',s}(T_t - I)P_t] A_{a,a'} S_{i,s} + offset(p_{i,a,t})\end{aligned}$$

Finally, the equation for the model with interactions between age and quintiles of the proportion racialized (model 3b) is:

$$\begin{aligned}\log(\lambda_{i,a,t}) = {} & \alpha + f(T_t) + \beta P_t + \delta(T_t - I)P_t + \sum_c (\psi_c * C_{i,a,c}) + \\ & \sum_{a'} [\gamma_{a'} + f_{a'}(T_t) + \beta_{a'} P_t + \delta_{a'}(T_t - I)P_t] * A_{a,a'} + \\ & \sum_v [\gamma_v + f(T_t) + \beta_v P_t + \delta_v(T_t - I)P_t] * V_{i,v} + \\ & \sum_{a',v} [\gamma_{a',v} + f_{a',v}(T_t) + \beta_{a',v} P_t + \delta_{a',v}(T_t - I)P_t] A_{a,a'} V_{i,v} + offset(p_{i,a,t})\end{aligned}$$

In these last two equations, the a',s and a',v subscripts indicate that the coefficients are specific to age group a' and income quintile s (or proportion racialized quintile v).

Sensitivity analyses

Inferences from interrupted time-series can be sensitive to the modeling of the counterfactual scenario.[3] We performed three different sensitivity analyses to estimate how alternative modeling choices would affect model fit, results, and conclusions.

First, we determined whether the estimated counterfactual (and thus, estimated impact of the vaccine passport) was sensitive to changing the starting date of the time-series. We compared the starting date of July 3rd to models starting one week earlier (June 26th) or one week later (July 10th).

Second, we determined whether the counterfactual was sensitive to changing the length of the impact period – i.e., the length during which the P_t variable equals 1– of the vaccine passport. We compared the best-fitting model of six weeks to models with an impact period of either five or seven weeks.

Lastly, we tested whether a simpler model of the relationship between log-vaccination rate and calendar time would be able to capture the observed vaccination rates in Québec and Ontario and replicate our spline-based results. Given the different trends observed in vaccination rates over the summer, we used different models for each province (which we determined heuristically to fit the data well). For Québec, we modeled the log rate-time relationship with a linear trend and an indicator variable for the time period after the impact of the vaccine passport, i.e., after September 18th. In Ontario, we modeled the relationship with linear and quadratic terms for time, and an indicator variable for the month of July. We also tested a simple model in which the relationship between log vaccination rate and time is modeled via a simple linear relationship, to test whether this simpler model appropriately captured the pre-announcement vaccination trend in each province. The equations for these alternative models are provided below.

Best alternative model specifications

For both provinces, the best non-spline alternative model specifications are the same as the age-stratified model 1, except for how the time trend is modeled.

Alternative non-spline model specification for Québec

For Québec, we replace the splines for time $f(T_t)$ and $f_{a'}(T_t)$ by coefficients for time (in weeks) η and η_a. We also allow the intercept and slope of the log vaccination rate after the vaccine passport impact "wears off" to differ from the pre-announcement vaccination rate, via coefficients θ, $\theta_{a'}$, κ and $\kappa_{a'}$. The time period after which the vaccine passport is presumed to have an effect is denoted by R_t, which is equal to 1 after the end of the impact period (Québec: after September 18th, Ontario: after October 9th) and 0 otherwise. As before, coefficients without a subscript are the coefficients for the reference age group, and coefficients with the subscript a' are the components of a vector of coefficients for the remaining age groups. The formula for this model is:

$$\log(\lambda_{i,a,t}) = \alpha + \eta T_t + \beta P_t + \delta(T_t - I)P_t + \theta R_t + \kappa(T_t - I - 6)R_t + \sum_{a'}[\theta_{a'}R_t + \kappa_{a'}(T_t - I - 6)R_t]A_{a,a'} + \sum_{a'}[\gamma_{a'} + \eta_{a'}T_t + \beta_{a'}P_t + \delta_{a'}(T_t - I)P_t]A_{a,a'} + \sum_{c}(\psi_c * C_{i,a,c}) + offset(p_{i,a,t})$$

Alternative non-spline model specification for Ontario

For Ontario, the coefficients θ, $\theta_{a'}$, κ and $\kappa_{a'}$ are used to allow the intercept and slope of the vaccination rate to differ in July, denoted by the indicator variable J_t, which is 1 for the timepoints in July (first 5 timepoints). The coefficients for the quadratic term are ω and $\omega_{a'}$, and the formula is:

$$\log(\lambda_{i,a,t}) = \alpha + \eta T_t + \beta P_t + \delta(T_t - I)P_t + \theta J_t + \kappa T_t J_t + \omega T_t + \sum_{a'}[\theta_{a'} J_t + \kappa_{a'} T_t J_t + \omega_a T_t] A_{a,a'} + \sum_{a'}[\gamma_{a'} + \eta_{a'} T_t + \beta_{a'} P_t + \delta_{a'}(T_t - I)P_t] A_{a,a'} + \sum_c (\psi_c * C_{i,a,c}) + offset(p_{i,a,t})$$

Linear model between log vaccination rate and time

The linear models are as above, except that the spline for time is only replaced by the η and η_a coefficients. No other coefficients or quadratic terms are used.

$$\log(\lambda_{i,a,t}) = \alpha + \eta T_t + \beta P_t + \delta(T_t - I)P_t + \sum_{a'}[\gamma_{a'} + \eta_{a'} T_t + \beta_{a'} P_t + \delta_{a'}(T_t - I)P_t] A_{a,a'} + \sum_c (\psi_c * C_{i,a,c}) + offset(p_{i,a,t})$$

References for the supplementary methods

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Supplementary results

Supplementary Table S1. Population sizes and first-dose COVID-19 vaccine coverage for select time points in the Montréal and Toronto census metropolitan areas, 2021.

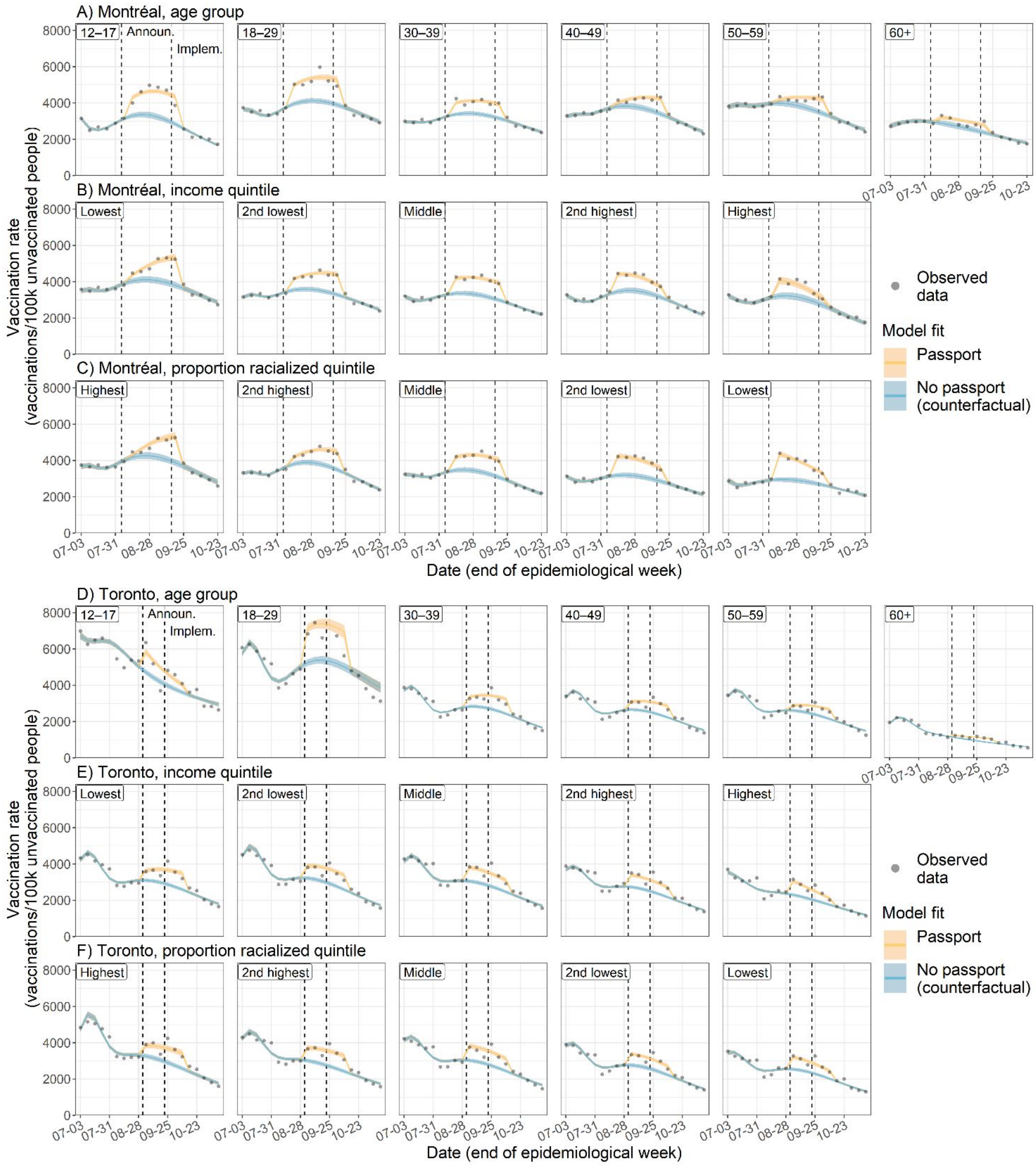
			COVID-19 first-dose vaccine coverage (%)		
			Start of timeseries	Last pre-announcement time point	End of time-series
Province and age group	**Number of DAs**	**Population (≥12 years)**	**July 3rd 2021**	**August 7th 2021**	**October 23rd 2021**
Québec	**6,437**	**3,696,253**	**78.9%**	**82.2%**	**88.1%**
12–17 years		299,847	60.0%	65.2%	76.3%
18–29 years		639,506	69.1%	74.1%	84.1%
30–39 years		600,349	69.5%	73.9%	82.2%
40–49 years		584,213	78.3%	81.8%	87.8%
50–59 years		543,385	85.2%	87.9%	91.9%
60+ years		1,028,953	93.2%	94.1%	95.6%
			July 3rd 2021	**August 28th 2021**	**November 13th 2021**
Ontario	**7,333**	**5,777,554**	**77.4%**	**82.8%**	**87.2%**
12–17 years		442,406	65.2%	78.9%	86.6%
18–29 years		1,080,806	77.1%	84.8%	91.9%
30–39 years		991,693	72.1%	78.1%	83.8%
40–49 years		881,175	77.0%	81.7%	86.1%
50–59 years		903,509	81.9%	85.7%	88.9%
60+ years		1,477,965	82.2%	84.4%	86.0%

DA, dissemination area.

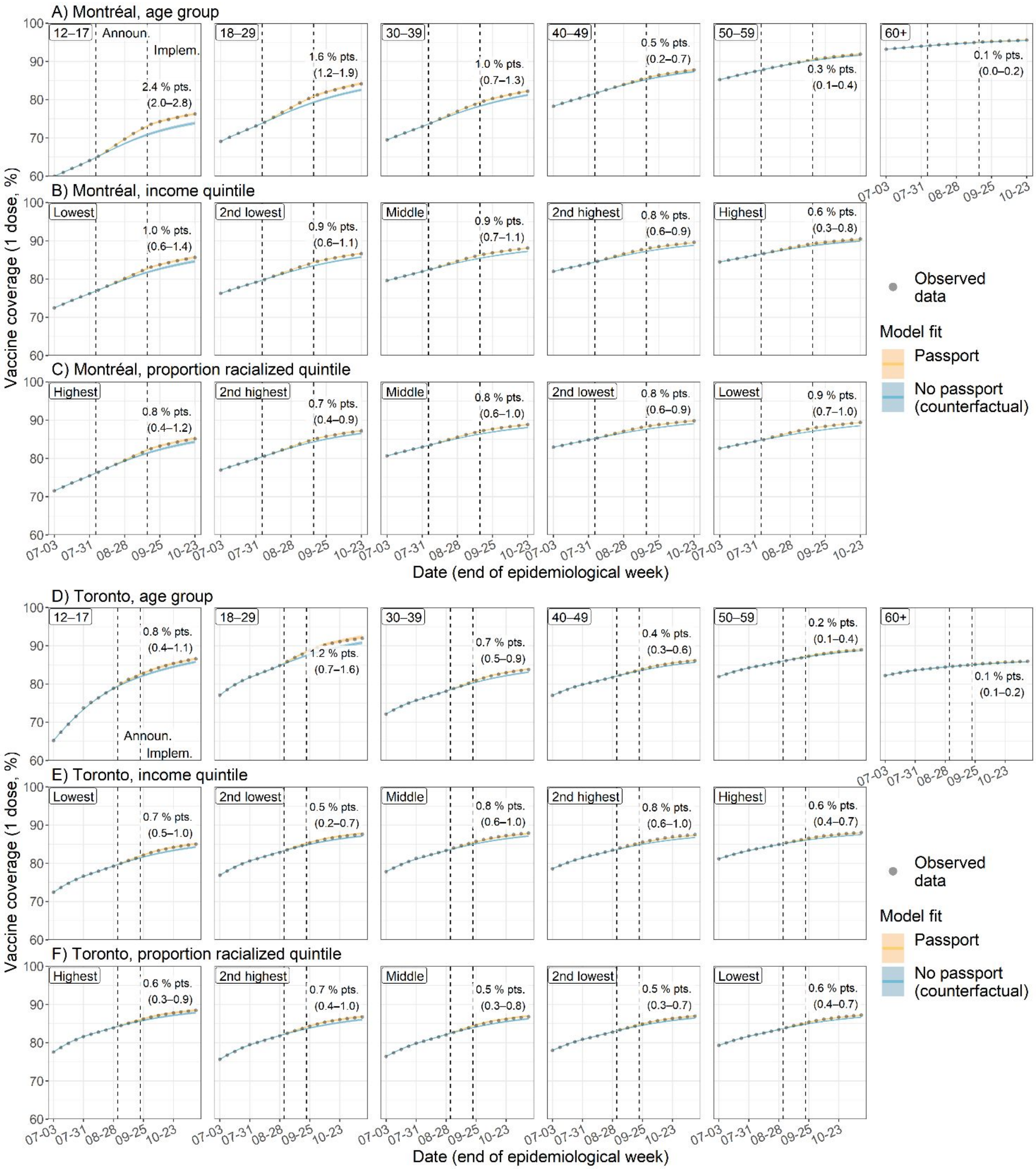
Supplementary Table S2. First-dose COVID-19 vaccination coverage before the vaccine passport announcement, absolute and relative impact of the vaccine passport in Québec and Ontario by age, income quintile, and proportion racialized quintile.

	Québec		
	Pre-announcement vaccine coverage (%)	**Absolute impact (p.p. change in coverage)**	**Relative impact (% increase in doses)**
Age			
12–17	67.6	2.3 (2.0–2.7)	36 (28–43)
18–29	72.1	1.8 (1.0–2.5)	28 (13–43)
30–39	72.3	1.2 (0.6–1.7)	22 (9.9–33)
40–49	80.6	0.7 (0.1–1.1)	16 (2.3–30)
50–59	87.3	0.4 (-0.1–0.8)	16 (-1.7–36)
60+	94.3	0.1 (0.0–0.3)	14 (-2.7–32)
Income quintile			
Lowest	77.3	1.1 (0.2–1.8)	21 (3.8–40)
2nd lowest	80.6	0.9 (0.3–1.4)	22 (6.8–38)
Middle	82.5	1.0 (0.5–1.3)	28 (13–42)
2nd highest	84.4	0.9 (0.6–1.2)	30 (16–42)
Highest	86.6	0.7 (0.4–0.8)	27 (15–36)
Proportion racialized quintile			
Highest	78.1	0.8 (0.5–1.0)	12 (7.5–18)
2nd highest	83.2	0.8 (0.6–0.9)	21 (16–26)
Middle	84.7	0.9 (0.7–1.1)	30 (22–39)
2nd lowest	83.5	1.0 (0.7–1.2)	33 (20–42)
Lowest	82.0	0.9 (0.4–1.1)	29 (9.8–41)
	Ontario		
	Pre-announcement vaccine coverage (%)	**Absolute impact (p.p. change in coverage)**	**Relative impact (% increase in doses)**
Age			
12–17	76.2	1.3 (0.9–1.7)	22 (14–30)
18–29	79.9	1.3 (0.9–1.7)	24 (15–33)
30–39	74.2	1.0 (0.8–1.2)	21 (17–25)
40–49	80.0	0.6 (0.4–0.7)	15 (11–20)
50–59	85.9	0.2 (0.1–0.4)	9.2 (4.8–14)
60+	86.6	0.1 (0.1–0.2)	12 (6.2–18)
Income quintile			
Lowest	77.7	0.8 (0.5–1.2)	19 (9.5–29)
2nd lowest	80.8	0.7 (0.5–0.9)	18 (12–25)
Middle	82.0	0.8 (0.6–1.0)	24 (18–31)
2nd highest	82.7	0.8 (0.7–0.9)	27 (21–33)
Highest	84.8	0.7 (0.6–0.8)	32 (25–40)
Proportion racialized quintile			
Highest	82.6	0.7 (0.4–0.9)	19 (11–27)
2nd highest	81.9	0.7 (0.5–0.9)	19 (13–26)
Middle	82.8	0.7 (0.6–0.8)	23 (17–29)
2nd lowest	81.6	0.8 (0.6–0.9)	24 (19–29)
Lowest	79.1	0.7 (0.5–0.9)	19 (12–25)

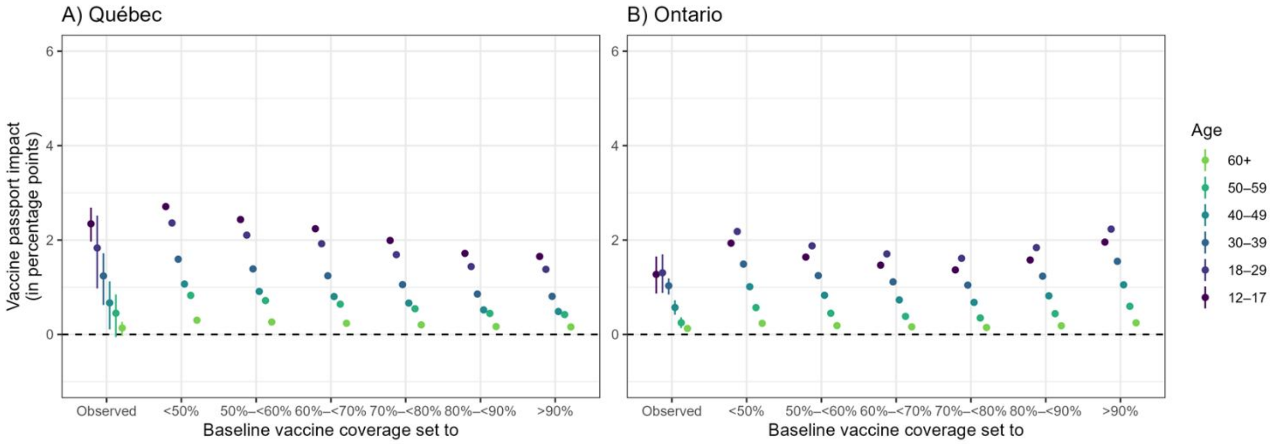
The pre-announcement vaccination coverage corresponds to the coverage as of August 7th (Québec) or August 28th (Ontario), 2021. Absolute impact was estimated as observed coverage minus modeled counterfactual by the end of the study period, October 23rd (Québec) or November 13th (Ontario), 2021. The relative impact was estimated as the observed number of doses administered divided by the modeled counterfactual number of doses, during the period between the passport announcement and the end of the study period. Columns for the estimated impact show the point estimate and the 95% confidence intervals (CIs) in parenthesis. 95% CIs were estimated via bootstrap with 1,000 replicates.



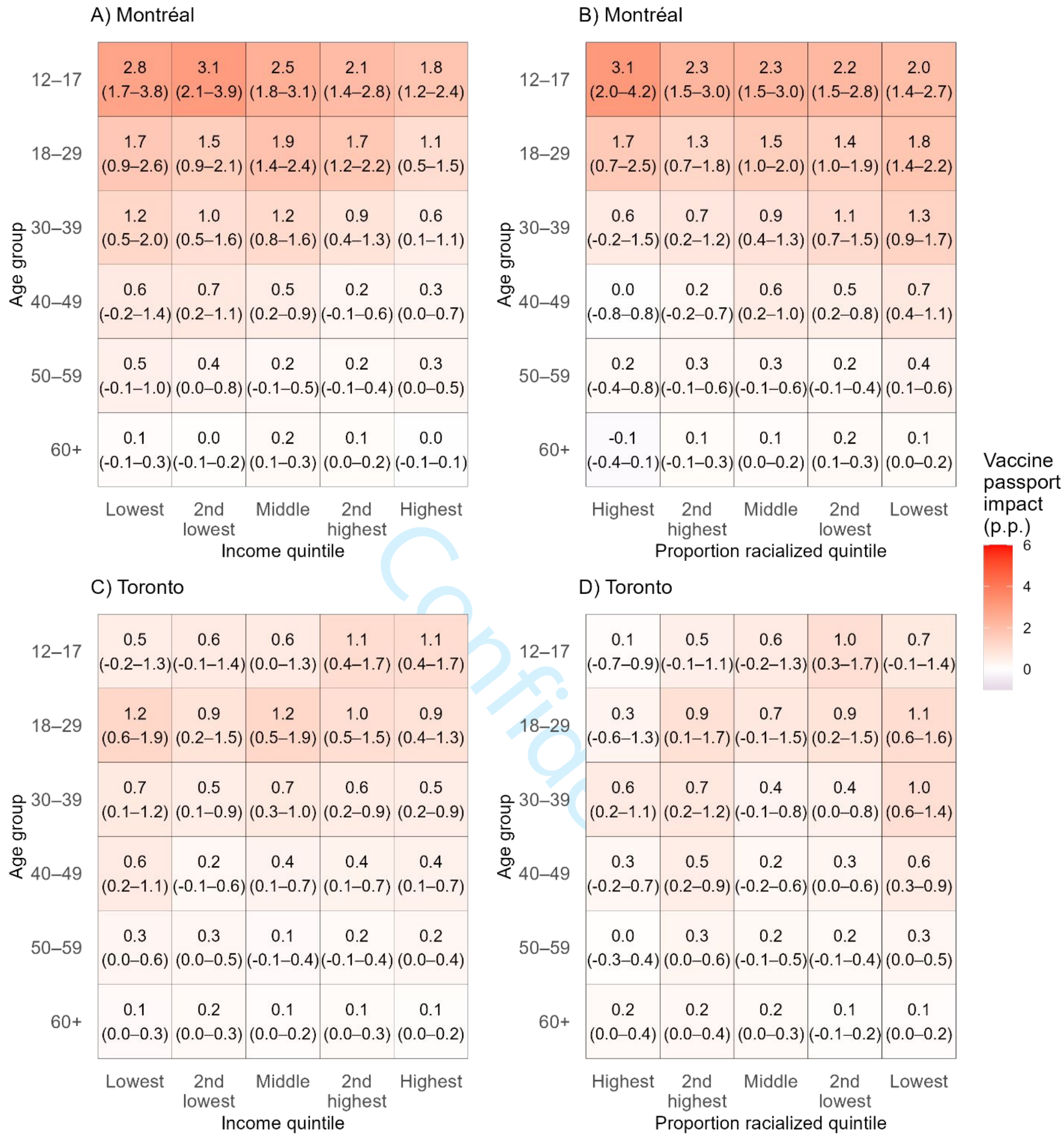
Supplementary Figure S1. Weekly vaccination rates in Montréal (A–C) and Toronto (D–F). Observed (points) and modeled (blue and yellow) vaccination rates over time are shown. Predicted vaccination rates were obtained from three different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by age group (A, D), DA-level income quintile (B, E), or DA-level proportion racialized quintile (C, F). 95% confidence intervals were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



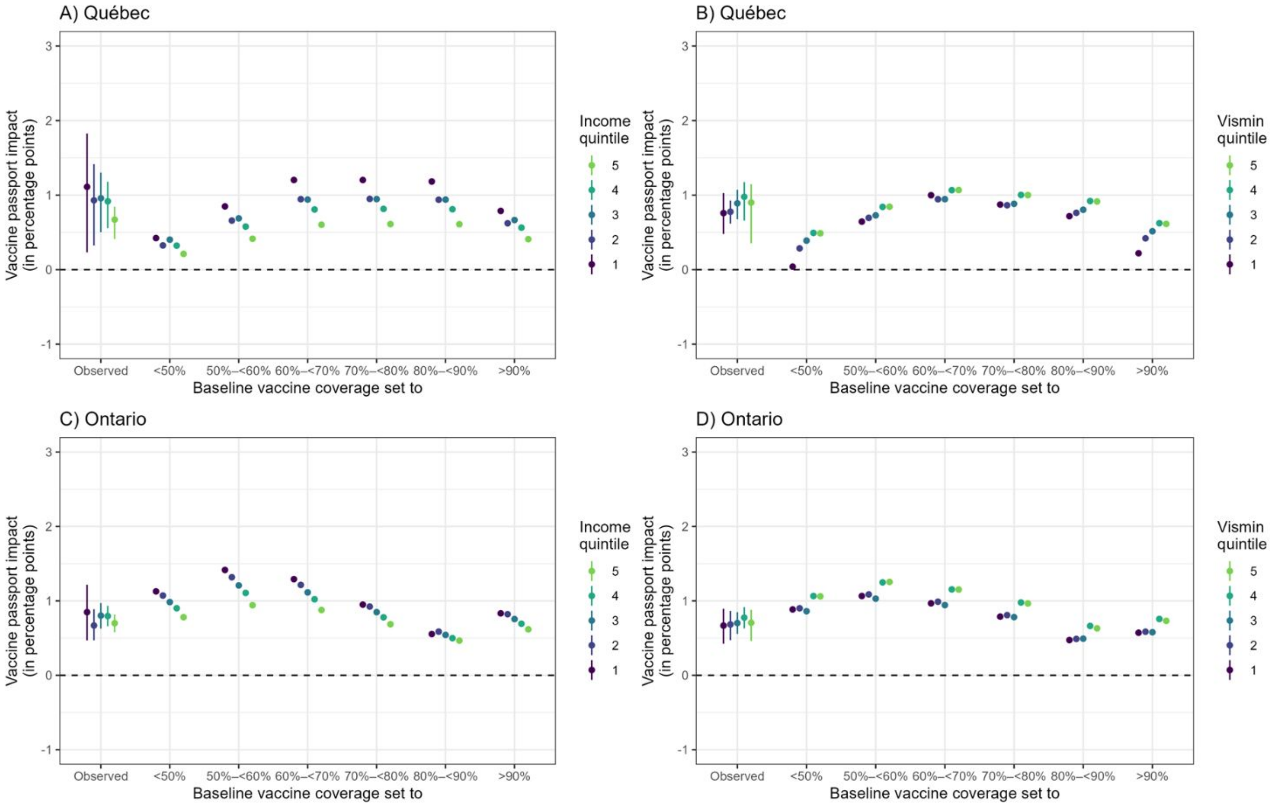
Supplementary Figure S2. First-dose COVID-19 vaccine coverage in Montréal (A–C) and Toronto (D–F). Observed (points) and modeled (blue and yellow) vaccine coverage over time are shown. Predicted vaccine coverage was obtained from three different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by age group (A, D), DA-level income quintile (B, E), or DA-level proportion racialized quintile (C, F). Estimates and 95% confidence intervals (CIs) of the impact of the vaccine passport (observed coverage minus modeled counterfactual) are shown at the right of each panel. 95% CIs were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



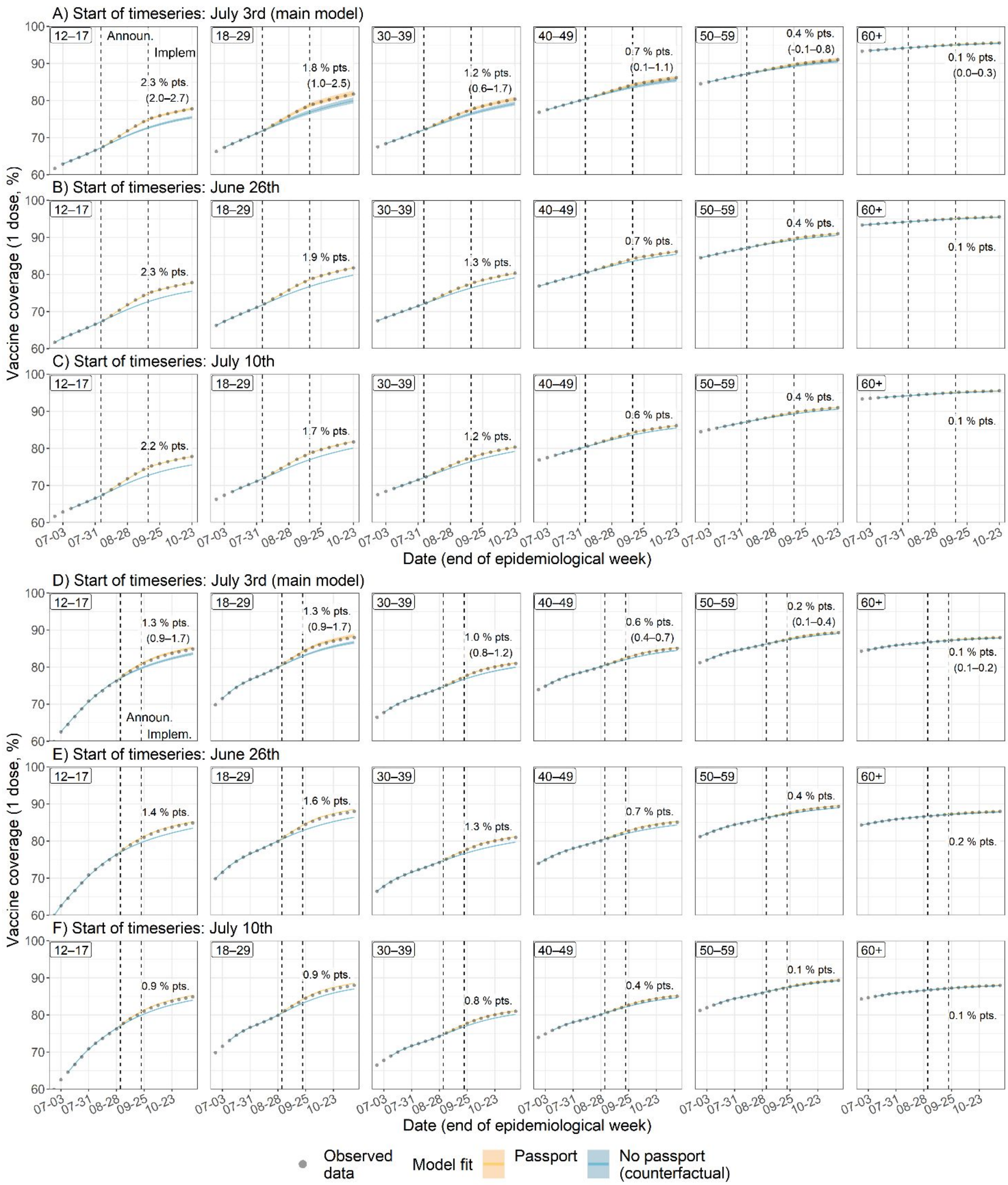
Supplementary Figure S3. Impact of vaccine passport on first-dose coverage of COVID-19 vaccine (in percentage points) across age groups when holding baseline coverage constant for all dissemination areas (DA) in Québec (A) and Ontario (B) by the end of the study period. The vaccine passport's impact (observed [or modeled] vaccination coverage minus the modeled counterfactual coverage in the absence of a vaccine passport) was estimated from a regression model where the vaccination rate and the impact of the vaccine passport were allowed to vary by age group and baseline coverage.



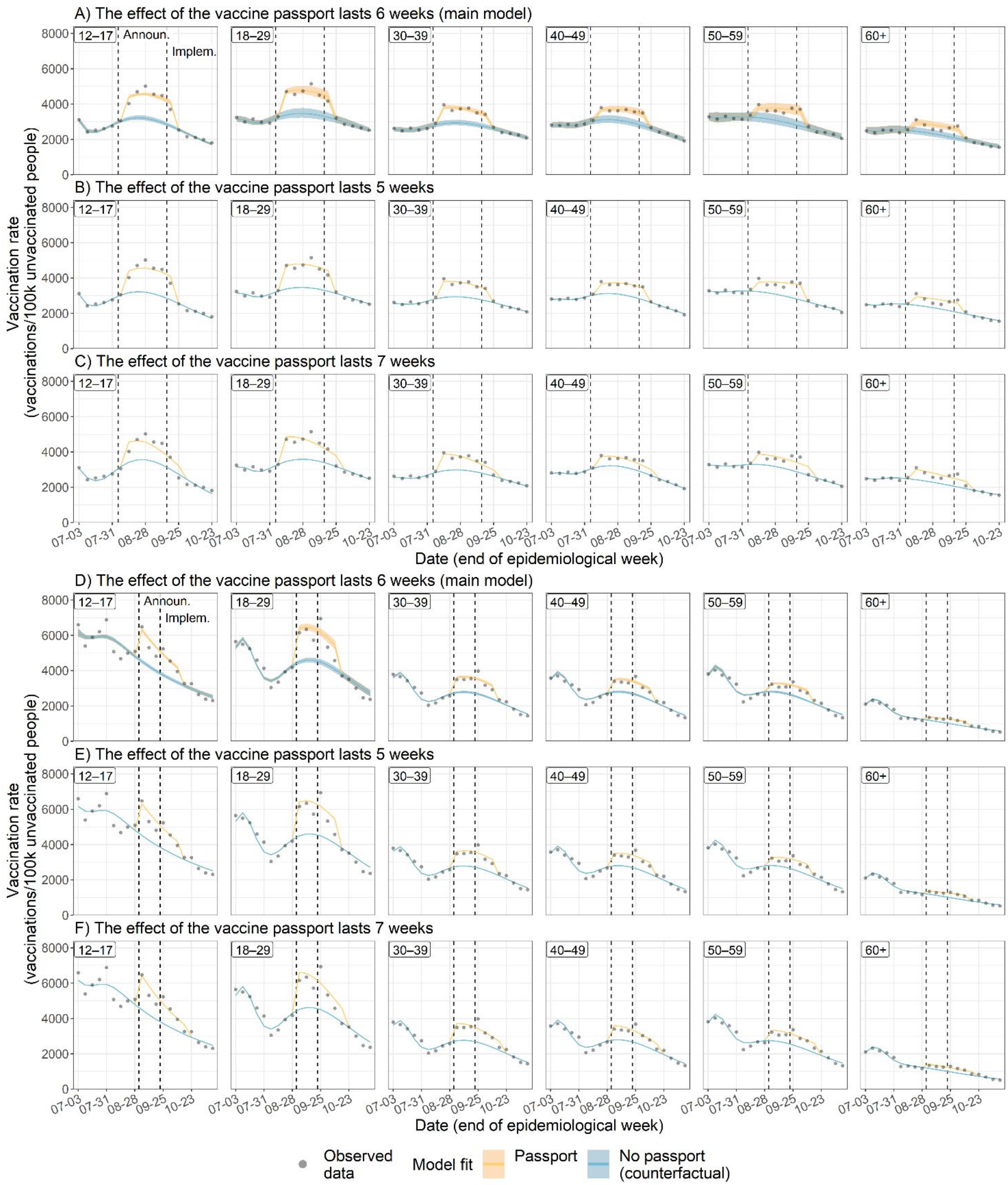
Supplementary Figure S4. Impact of vaccine passport on first-dose coverage of COVID-19 vaccine (in percentage points) across age and by dissemination area (DA) level of income and proportion of racialized residents in Montréal (A, B) and Toronto (C, D) by the end of the study period. The vaccine passport's impact (defined as the observed vaccination coverage minus the modeled counterfactual coverage in the absence of a vaccine passport) was estimated from two different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by the interaction of age and either DA-level income quintile (A, C), or DA-level proportion racialized quintile (B, D). 95% confidence intervals –shown in parenthesis– were estimated via bootstrap with 1,000 replicates. p.p., percentage points.



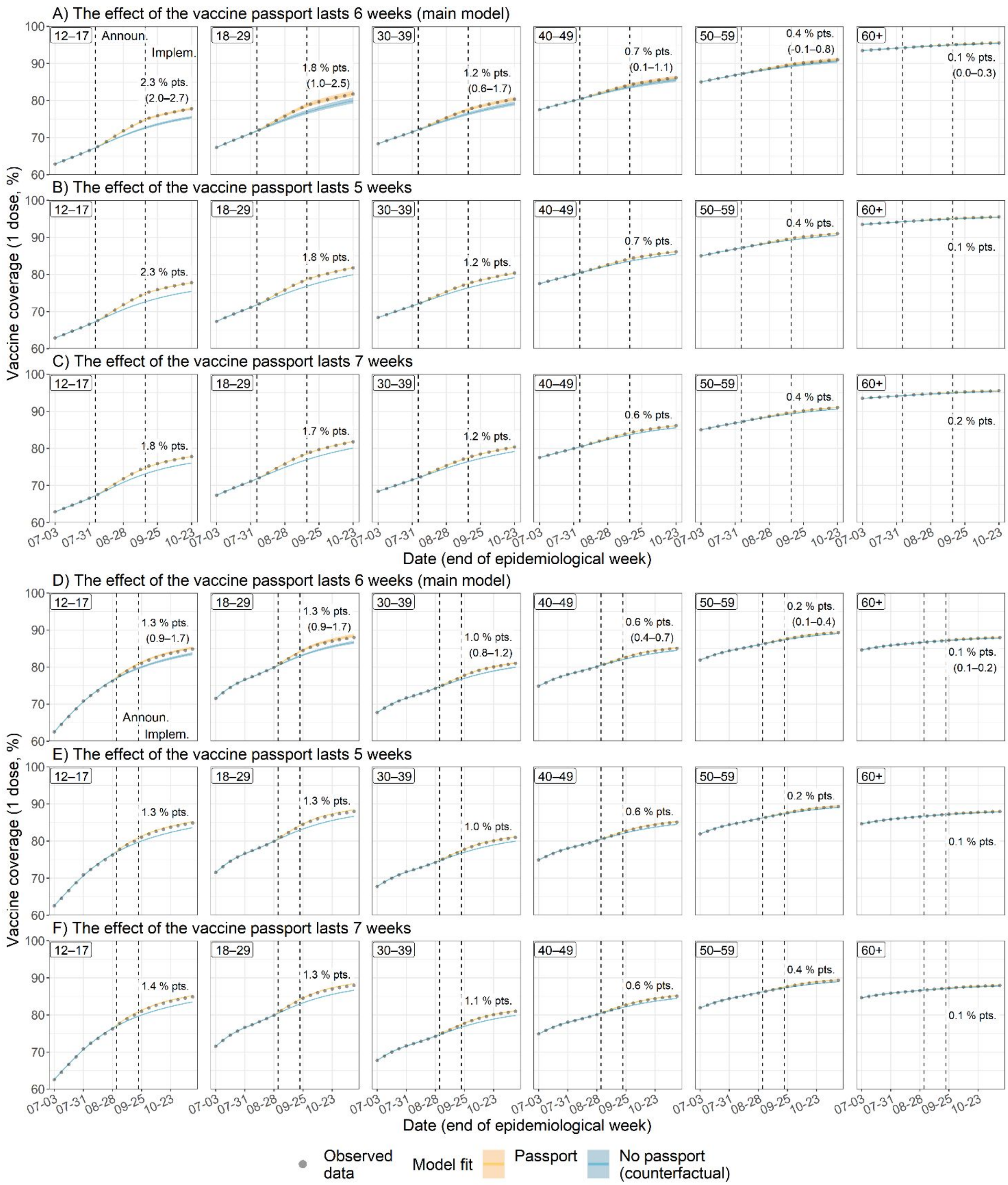
Supplementary Figure S5. Impact of vaccine passport on first-dose coverage of COVID-19 vaccine (in percentage points) across social determinants when holding baseline coverage constant for all dissemination areas (DA) in Québec (A, B) and Ontario (C, D) by the end of the study period. The vaccine passport's impact (observed [or modeled] vaccination coverage minus the modeled counterfactual coverage in the absence of a vaccine passport) was estimated from two different regression models where the vaccination rate and the impact of the vaccine passport were allowed to vary by baseline vaccine coverage and either DA-level income quintile (A, C), or DA-level proportion racialized quintile (B, D).



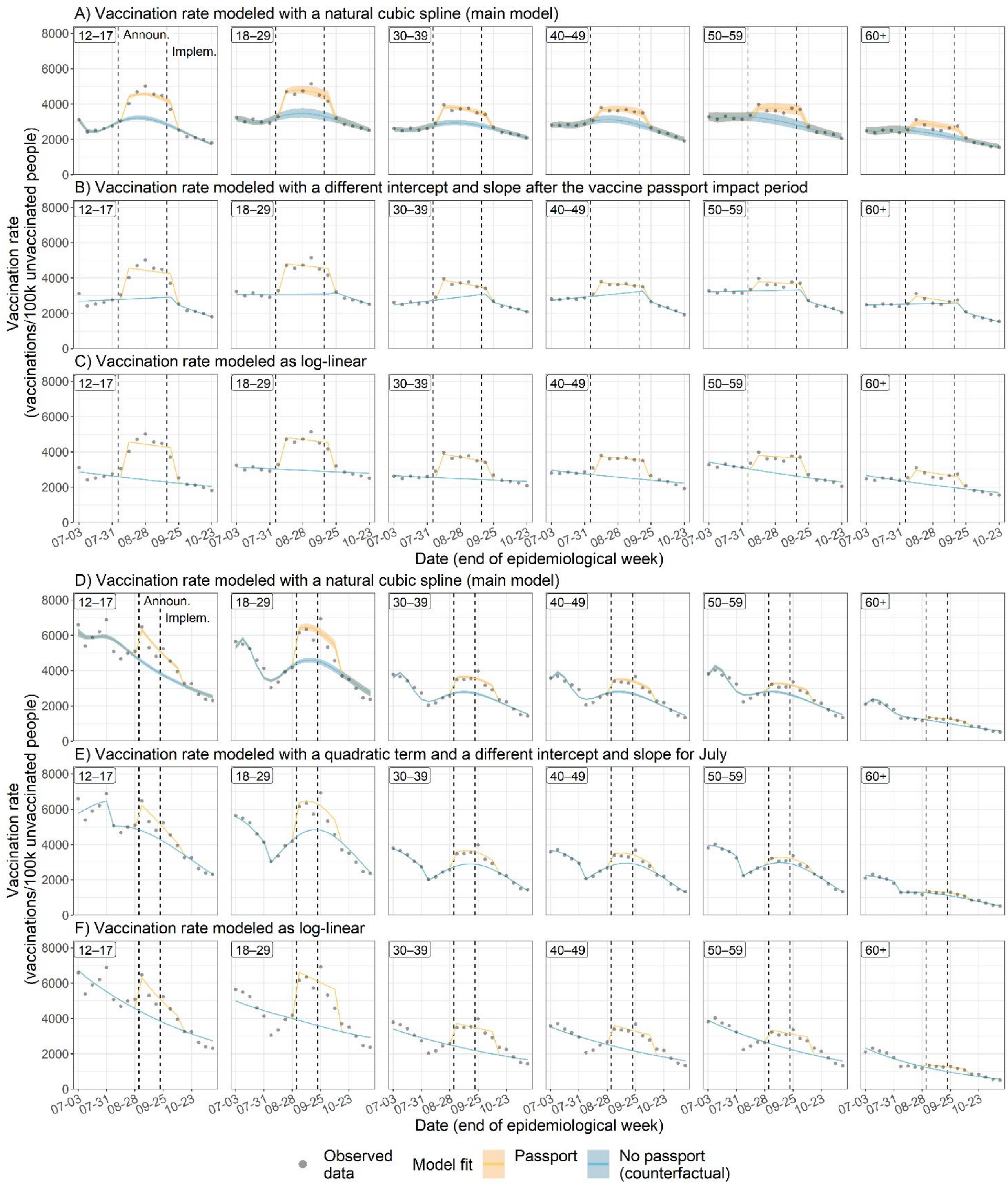
Supplementary Figure S6. Impact of changing start of timeseries on first-dose COVID-19 vaccine coverage and the estimated vaccine passport effect in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccination rate over time are shown. Each row presents model fits from a different regression model, all of which allow the impact of the vaccine passport to vary by age group. Data for the regression models starts on July 3rd (main model; A,D), June 26th (B,E) or July 10th (C,F). Estimates and 95% confidence intervals (CIs) of the impact of the vaccine passport (observed coverage minus modeled counterfactual) are shown at the right of each panel. 95% CIs were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



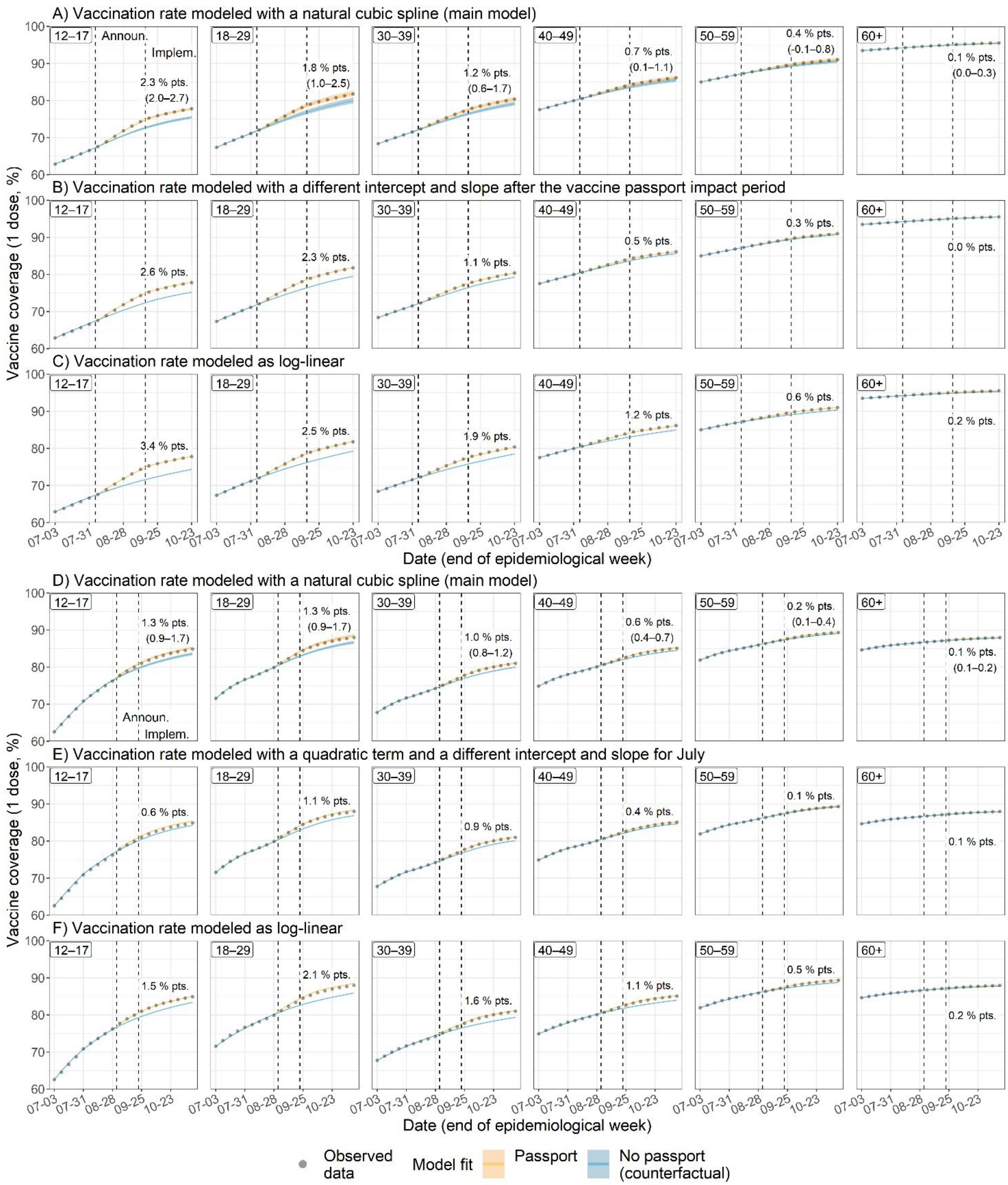
Supplementary Figure S7. Impact of changing the length of the vaccine passport impact period on the weekly vaccination rate in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccination rates over time are shown. Each row presents model fits from a different regression model, all of which allow the impact of the vaccine passport to vary by age group. The vaccine passport was assumed to have an impact for a period of six weeks (main model; A,D), five weeks (B,E), or seven weeks (C,F). 95% confidence intervals were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



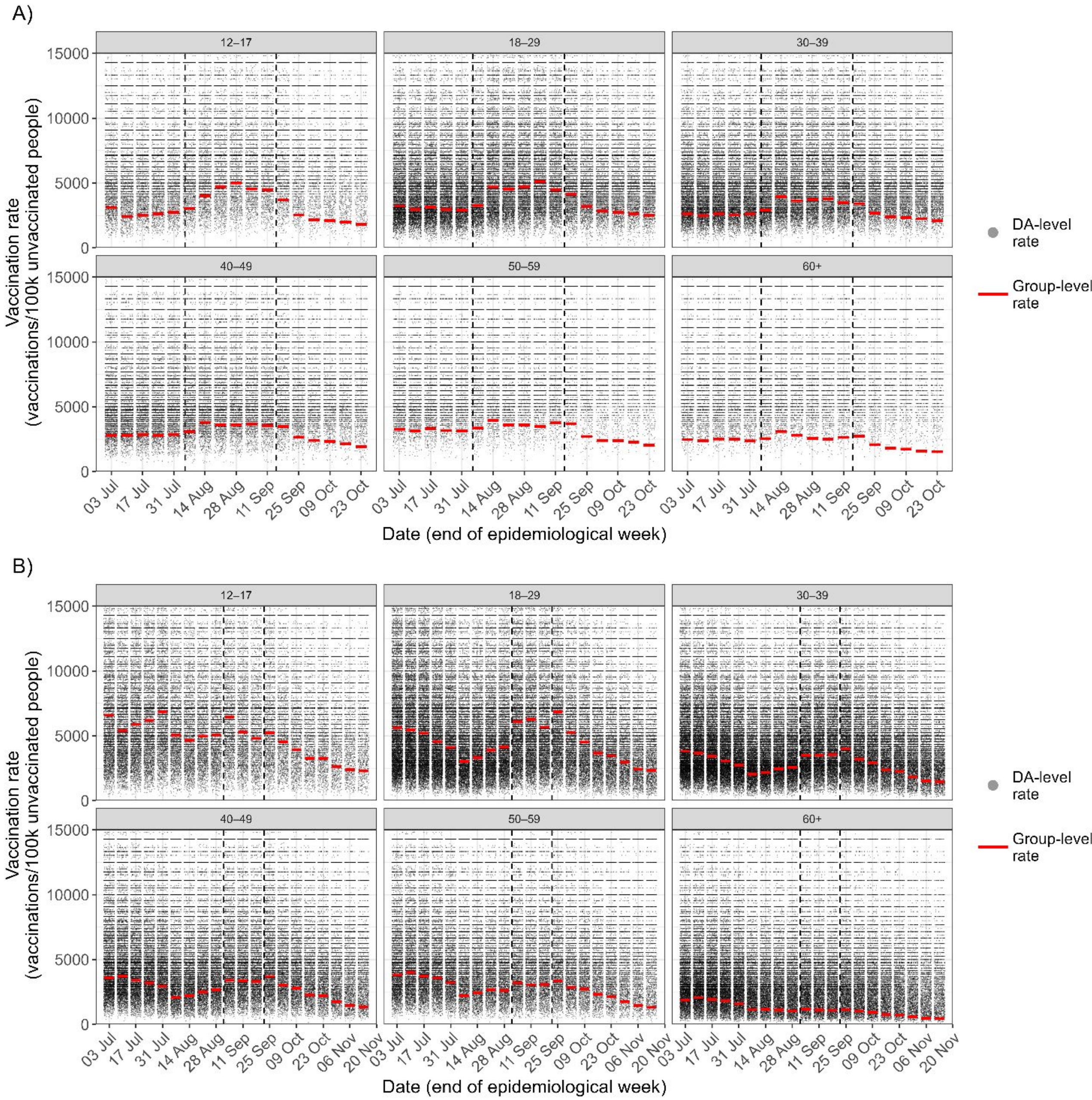
Supplementary Figure S8. Impact of changing the length of the vaccine passport impact period on first-dose COVID-19 vaccine coverage and the estimated vaccine passport effect in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccination coverage over time are shown. Each row presents model fits from a different regression model, all of which allow the impact of the vaccine passport to vary by age group. The vaccine passport was assumed to have an impact for a period of six weeks (main model; A,D), five weeks (B,E), or seven weeks (C,F). Estimates and 95% confidence intervals (CIs) of the impact of the vaccine passport (observed coverage minus modeled counterfactual) are shown at top right of each panel. 95% CIs were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



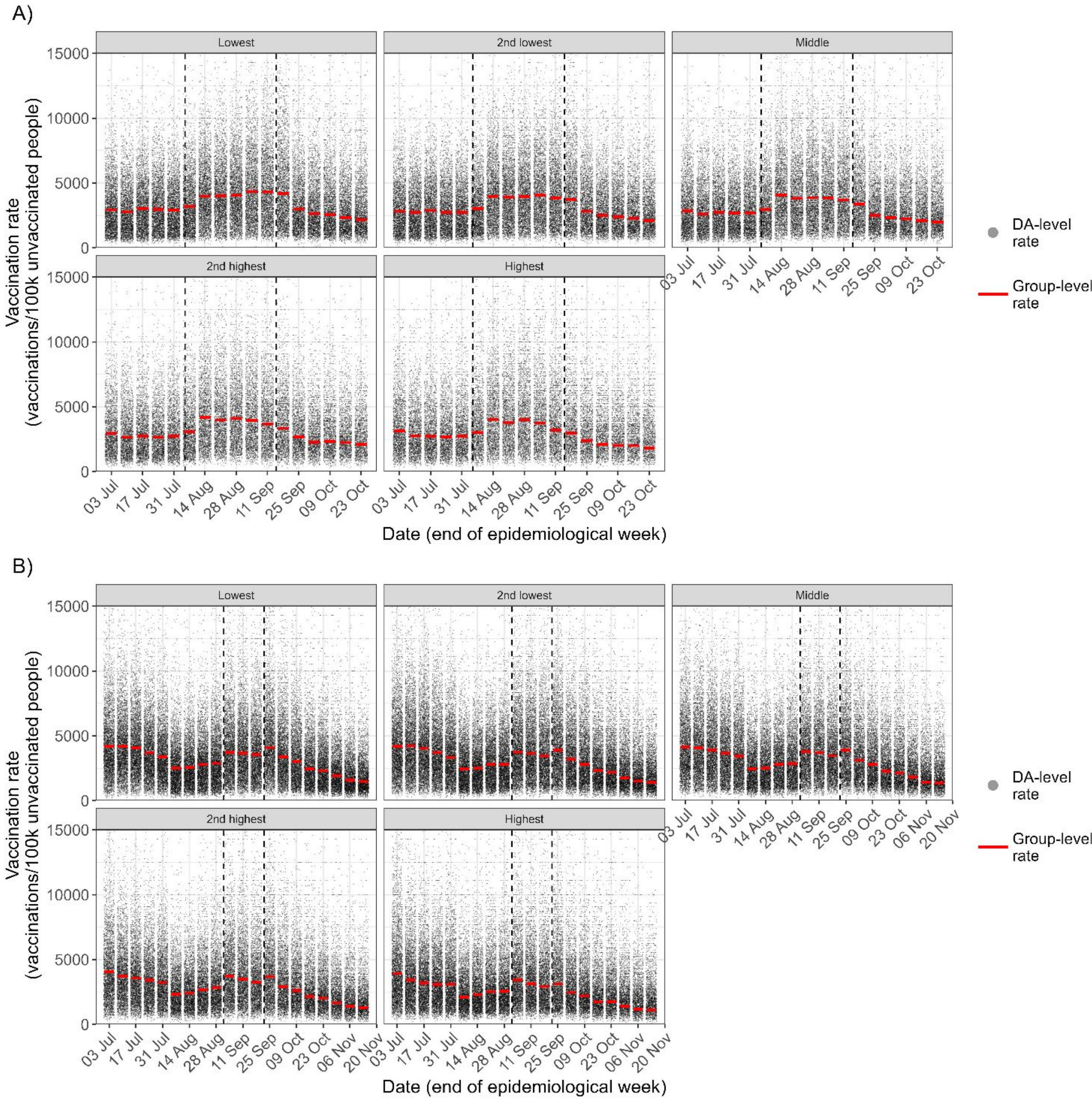
Supplementary Figure S9. Impact of changing how the temporal trend is modeled on the weekly vaccination rate in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccination rates over time are shown. Each row presents model fits from a different regression model, all of which allow the impact of the vaccine passport to vary by age group. The vaccination rate-calendar time relationship is modeled with a natural spline (main model; A,D), a change in level and slope after the end of the vaccine passport's impact period (B), a quadratic term and a change in level and slope in July (D), or a log-linear relationship (C,F). 95% confidence intervals were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



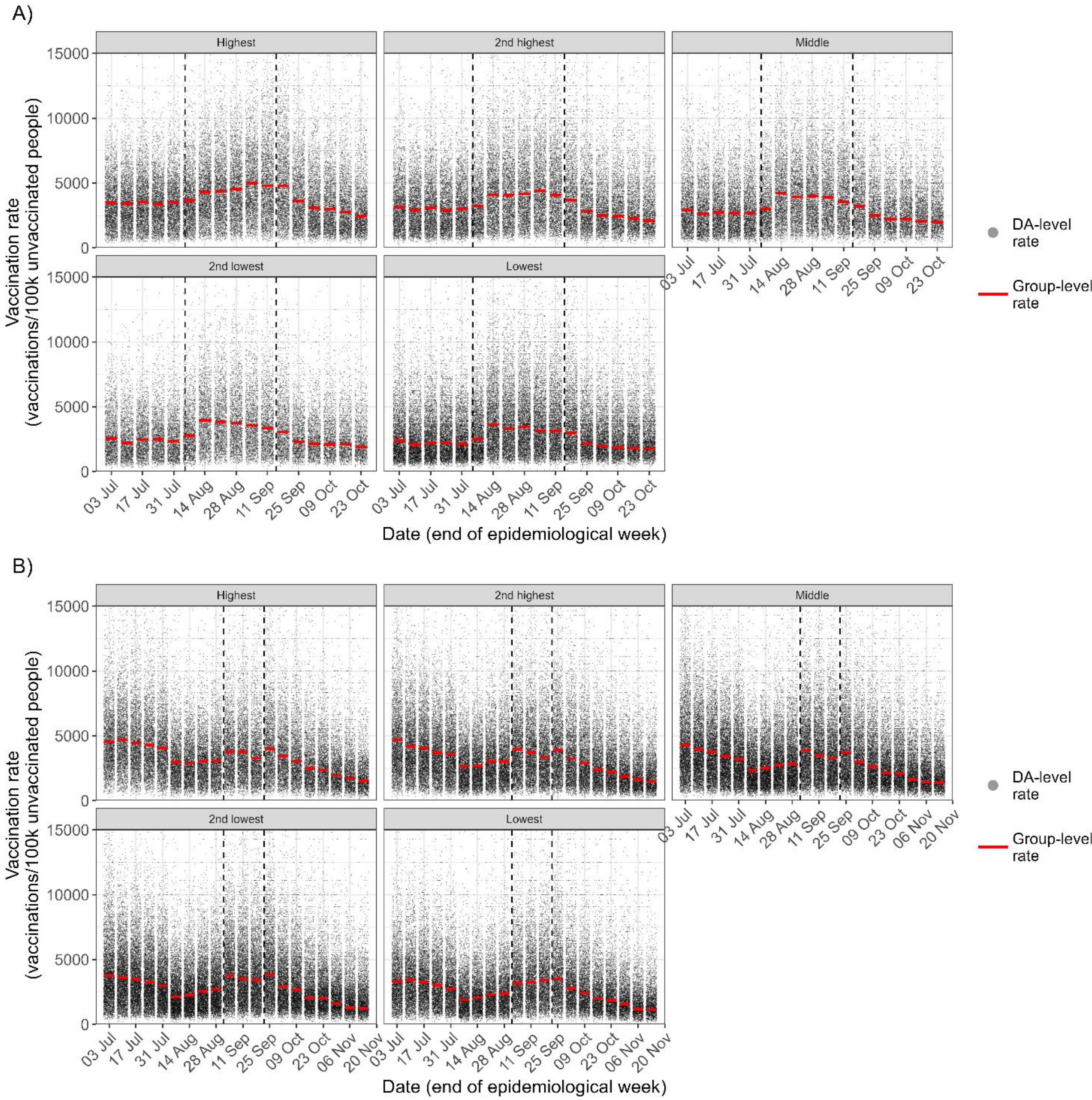
Supplementary Figure S10. Impact of changing how the temporal trend is modeled on first-dose COVID-19 vaccine coverage and the estimated vaccine passport effect in Québec (A–C) and Ontario (D–F). Observed (points) and modeled (blue and yellow) vaccination coverage over time are shown. Each row presents model fits from a different regression model, all of which allow the impact of the vaccine passport to vary by age group. The vaccination rate-calendar time relationship is modeled with a natural spline (main model; A,D), a change in level and slope after the end of the vaccine passport's impact period (B), a quadratic term and a change in level and slope in July (D), or a log-linear relationship (C,F). Estimates and 95% confidence intervals (CIs) of the impact of the vaccine passport (observed coverage minus modeled counterfactual) are shown at the right of each panel. 95% CIs were estimated via bootstrap with 1,000 replicates. Announ., announcement of the vaccine passport; Implem., implementation of the vaccine passport.



Supplementary Figure S11. Distribution of the dissemination area (DA)-level weekly vaccination rate by age group in Québec (A) and Ontario (B). Observed weekly vaccination rates over time are shown, each dot represents data from a single DA and each panel shows a different age group. DA, dissemination area.



Supplementary Figure S12. Distribution of the dissemination area (DA)-level weekly vaccination rate by income quintile in Québec (A) and Ontario (B). Observed weekly vaccination rates over time are shown, each dot represents data from a single DA and each panel shows a different income quintile. DA, dissemination area.



Supplementary Figure S13. Distribution of the dissemination area (DA)-level weekly vaccination rate by proportion racialized quintile in Québec (A) and Ontario (B). Observed weekly vaccination rates over time are shown, each dot represents data from a single DA and each panel shows a different quintile of proportion racialized. DA, dissemination area.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3–4
Methods			
Study design	4	Present key elements of study design early in the paper	4–7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4–5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4–6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4–5, suppl. 1
Bias	9	Describe any efforts to address potential sources of bias	4–5, 6
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4–6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5–7
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7–8
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	7–8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9–15
		(*b*) Report category boundaries when continuous variables were categorized	11–14
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11–16
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16–19
Generalisability	21	Discuss the generalisability (external validity) of the study results	18–19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.